

What is claimed is:

1. A process for preparing a polar olefin copolymer comprising:

copolymerizing a non-polar olefin and a polar olefin

5 in the presence of a catalyst comprising

(A0) a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (1):



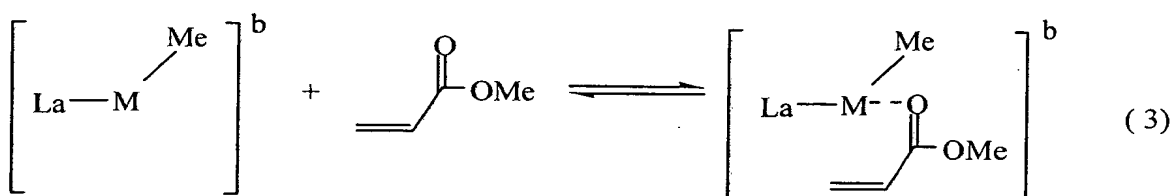
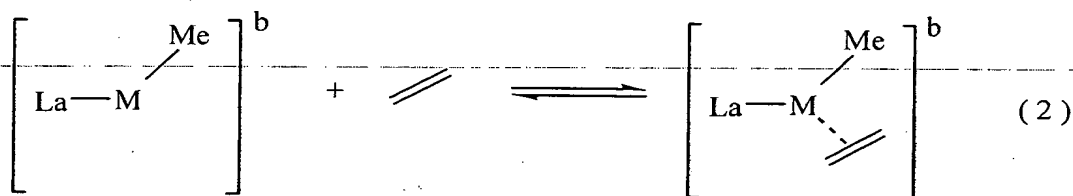
10 wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

m is an integer of 1 to 6,

n is a number satisfying a valence of M,

L is a ligand coordinated to M and each ligand L has  
15 a feature that when the value obtained by subtracting the total sum of the whole energy, as determined by a density functional method, of the compounds on the left-hand member from the whole energy, as determined by a density functional method, of the compound on the right-hand  
20 member in the following chemical formula (2) and the value obtained by the same subtraction in the following chemical formula (3) are defined as coordination energy  $E_1$  of ethylene and coordination energy  $E_2$  of methyl acrylate, respectively, the difference  $\Delta E$  ( $\Delta E = E_1 - E_2$ ) between the  
25 coordination energy  $E_1$  of ethylene and the coordination

energy  $E_2$  of methyl acrylate is 50 kJ/mol or less,



5        wherein M is the same transition metal atom selected from Groups 3 to 11 of the periodic table as M in the formula (1), a is an integer of 1 to 3, b is an electric charge of the compound in the blankets [ ] and is 0 or 1, and Me is a methyl group,

10      and

      X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a  
15    phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, silicon-containing group, a germanium-containing group and a tin-containing group, and when n is 2 or greater, plural atoms or groups

indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring.

5 2. A process for preparing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising

(A0) a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented  
10 by the formula (1) as defined in claim 1, and

(B) at least one compound selected from the group consisting of

(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

15 (B-3) a compound which reacts with a transition metal compound (A0) to form an ion pair.

3. The process for preparing a polar olefin copolymer as claimed in Claim 1 or 2, wherein the transition metal  
20 compound represented by the general formula (1) is a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table.

4. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A1) a reaction product of

- 5 (C) a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table which is represented by the following formula (c):



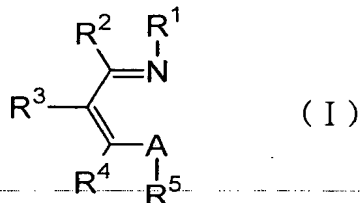
wherein M' is a transition metal atom selected from Groups  
10 4, 5, 6 and 11 of the periodic table,

k is a number satisfying a valence of M', and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a  
15 phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when k is 2 or greater, plural atoms or groups  
20 indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring, and

(A-i) a compound represented by the following formula

(I):



wherein A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent R<sup>6</sup>, and

R<sup>1</sup> to R<sup>6</sup> may be the same or different, they are each  
 5 a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a heterocyclic compound residual-group, a silicon-  
 10 containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring;  
 and

(B) at least one compound selected from the group  
 15 consisting of:

(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

(B-3) a compound which reacts with the reaction product (A1) to form an ion pair.

5. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A2) a reaction product of

- 5 (C) a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table which is represented by the following formula (c):

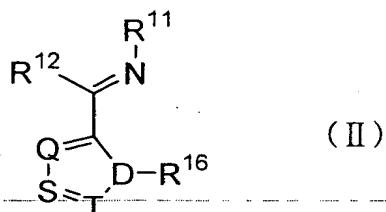


wherein M' is a transition metal atom selected from Groups  
10 4, 5, 6 and 11 of the periodic table,

k is a number satisfying a valence of M', and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a  
15 phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when k is 2 or greater, plural atoms or groups  
20 indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring, and

(A-ii) a compound represented by the following formula (II):



wherein D is a nitrogen atom or a phosphorus atom,

Q is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R<sup>13</sup>,

5        S is a nitrogen atom or a phosphorus atom, or a  
carbon atom substituted with a substituent R<sup>14</sup>,

T is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R<sup>15</sup>,

R<sup>11</sup> to R<sup>16</sup> may be the same or different, they are each  
a hydrogen atom, a halogen atom, a hydrocarbon group, an  
oxygen-containing group, a sulfur-containing group, a  
nitrogen-containing group, a boron-containing group, an  
aluminum-containing group, a phosphorus-containing group,  
a heterocyclic compound residual group, a silicon-  
containing group, a germanium-containing group or a tin-  
containing group, two or more of them may be bonded to  
each other to form a ring;  
and

(B) at least one compound selected from the group  
20 consisting of:

(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

(B-3) a compound which reacts with the reaction product (A2) to form an ion pair.

6. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A3) a reaction product of

(C') a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (c'):



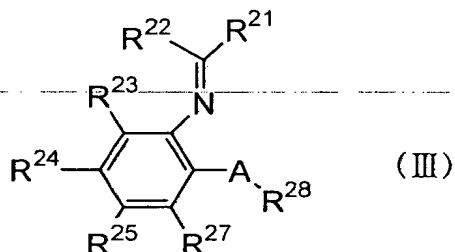
wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

k is a number satisfying a valence of M, and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when k is 2 or greater, plural atoms or groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring, and



(A-iii) a compound represented by the following formula (III):

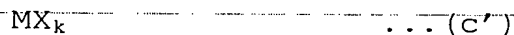


- 5 wherein A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent  $R^{26}$ , and
- $R^{21}$  to  $R^{28}$  may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a
- 10 nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to
- 15 each other to form a ring.

7. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

- 20 (A3) a reaction product of

(C') a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (c'):

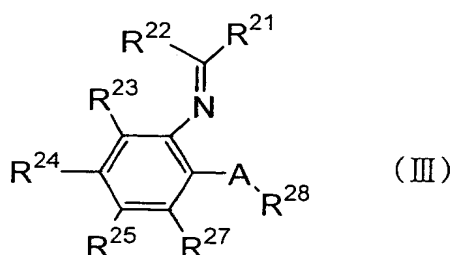


5 wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

k is a number satisfying a valence of M, and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when k is 2 or greater, plural atoms or groups indicated by X may be the same or different, and plural groups indicated by X may be bonded to each other to form a ring, and

(A-iii) a compound represented by the following  
20 formula (III):



wherein A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent  $R^{26}$ , and

$R^{21}$  to  $R^{28}$  may be the same or different, they are each  
a hydrogen atom, a halogen atom, a hydrocarbon group, an  
5 oxygen-containing group, a sulfur-containing group, a  
nitrogen-containing group, a boron-containing group, an  
aluminum-containing group, a phosphorus-containing group,  
a heterocyclic compound residual group, a silicon-  
containing group, a germanium-containing group or a tin-  
10 containing group, two or more of them may be bonded to  
each other to form a ring;  
and

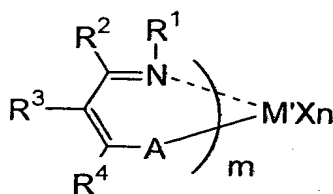
(B) at least one compound selected from the group  
consisting of:

- 15 (B-1) an organometallic compound,  
(B-2) an organoaluminum oxy-compound, and  
(B-3) a compound which reacts with the transition  
metal compound (A3) to form an ion pair.

20 8. The process for producing a polar olefin  
copolymer as claimed in claim 6 or 7, wherein the compound  
of a transition metal represented by the formula (c') is a  
compound of a transition metal selected from Groups 4, 5,  
6 and 11 of the periodic table.

9. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

- (A4) a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table, which is represented by the following formula (IV):



... (IV)

wherein M' is a transition metal atom selected from Groups 4, 5, 6 and 11 of the periodic table,

m is an integer of 1 to 6,

A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent R<sup>6</sup>,

R<sup>1</sup> to R<sup>4</sup> and R<sup>6</sup> may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, a heterocyclic compound residual group, an oxygen-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a sulfur-containing group, a phosphorus-containing group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring, and when m is 2 or greater,

one group of  $R^1$  to  $R^4$  and  $R^6$  contained in one ligand and one group of  $R^1$  to  $R^4$  and  $R^6$  contained in other ligands may be bonded, and  $R^1$ s,  $R^2$ s,  $R^3$ s,  $R^4$ s or  $R^6$ s may be the same or different,

5           n is a number satisfying a valence of  $M'$ , and

X is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a  
10   phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when n is 2 or greater, plural atoms or groups indicated by X may be the same or different, and plural  
15   groups indicated by X may be bonded to each other to form a ring;  
and

(B) at least one compound selected from the group consisting of:

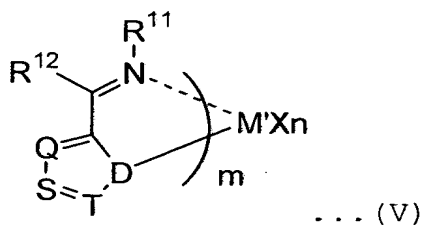
20           (B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

(B-3) a compound which reacts with the transition metal compound (A4) to form an ion pair.

10. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

- (A5) a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table which is represented by the following formula (V)



wherein M' is a transition metal atom selected from Groups 4, 5, 6 and 11 of the periodic table,

10 m is an integer of 1 to 6,

D is a nitrogen atom or a phosphorus atom,

Q is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R<sup>13</sup>,

15 S is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R<sup>14</sup>,

T is a nitrogen atom or a phosphorus atom, or a carbon atom substituted with a substituent R<sup>15</sup>,

R<sup>11</sup> to R<sup>15</sup> may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group,

20

a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring, and when  $m$  is 2 or greater, one

5 group of  $R^{11}$  to  $R^{15}$  contained in one ligand and one group of  $R^{11}$  to  $R^{15}$  contained in other ligands may be bonded, and  $R^{11}s$ ,  $R^{12}s$ ,  $R^{13}s$ ,  $R^{14}s$  or  $R^{15}s$  may be the same or different,

$n$  is a number satisfying a valence of  $M'$ , and

10  $X$  is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing  
15 group, a germanium-containing group or a tin-containing group, and when  $n$  is 2 or greater, plural atoms or groups indicated by  $X$  may be the same or different, and plural groups indicated by  $X$  may be bonded to each other to form a ring;

20 and

(B) at least one compound selected from the group consisting of:

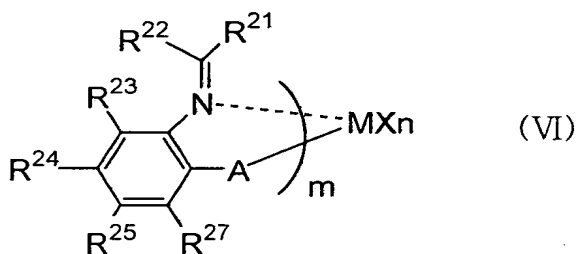
(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

(B-3) a compound which reacts with the transition metal compound (A5) to form an ion pair.

11. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A6) a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (VI):



wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

15        m is an integer of 1 to 6,

A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent R<sup>26</sup>,

R<sup>21</sup> to R<sup>27</sup> may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group,

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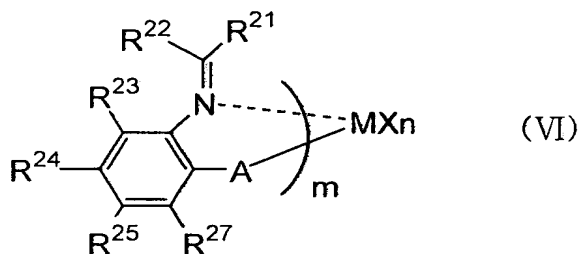


a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring, and when  $m$  is 2 or greater, one  
5 group of  $R^{21}$  to  $R^{27}$  contained in one ligand and one group of  $R^{21}$  to  $R^{27}$  contained in other ligands may be bonded, and  $R^{21}s$ ,  $R^{22}s$ ,  $R^{23}s$ ,  $R^{24}s$ ,  $R^{25}s$ ,  $R^{26}s$  or  $R^{27}s$  may be the same or different,

$n$  is a number satisfying a valence of  $M$ , and  
10  $X$  is a hydrogen atom, a halogen atom, an oxygen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a  
15 heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, and when  $n$  is 2 or greater, plural atoms or groups indicated by  $X$  may be the same or different, and plural groups indicated by  $X$  may be bonded to each other to form  
20 a ring.

12. A process for producing a polar olefin copolymer comprising copolymerizing a non-polar olefin and a polar olefin in the presence of a catalyst comprising:

(A6) a compound of a transition metal selected from Groups 3 to 11 of the periodic table, which is represented by the following formula (VI):



wherein M is a transition metal atom selected from Groups 3 to 11 of the periodic table,

m is an integer of 1 to 6,

A is an oxygen atom, a sulfur atom or a selenium atom, or a nitrogen atom having a substituent  $R^{26}$ ,

$R^{21}$  to  $R^{27}$  may be the same or different, they are each a hydrogen atom, a halogen atom, a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a heterocyclic compound residual group, a silicon-containing group, a germanium-containing group or a tin-containing group, two or more of them may be bonded to each other to form a ring, and when m is 2 or greater, one group of  $R^{21}$  to  $R^{27}$  contained in one ligand and one group of  $R^{21}$  to  $R^{27}$  contained in other ligands may be bonded, and

$R^{21}s$ ,  $R^{22}s$ ,  $R^{23}s$ ,  $R^{24}s$ ,  $R^{25}s$ ,  $R^{26}s$  or  $R^{27}s$  may be the same or different,

$n$  is a number satisfying a valence of  $M$ , and

$X$  is a hydrogen atom, a halogen atom, an oxygen atom,  
5 a hydrocarbon group, an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residual group, a silicon-containing  
10 group, a germanium-containing group or a tin-containing group, and when  $n$  is 2 or greater, plural atoms or groups indicated by  $X$  may be the same or different, and plural groups indicated by  $X$  may be bonded to each other to form a ring;

15 and

(B) at least one compound selected from the group consisting of:

(B-1) an organometallic compound,

(B-2) an organoaluminum oxy-compound, and

20 (B-3) a compound which reacts with the transition metal compound (A6) to form an ion pair.

13. The process for producing a polar olefin copolymer as claimed in claim 11 or 12, wherein the  
25 compound of a transition metal represented by the formula

(VI) is a compound of a transition metal selected from Groups 4, 5, 6 and 11 of the periodic table.

$$50B A_1 >$$

14. A polar olefin copolymer obtained by the process  
5 according to any one of claims 1 to 13.

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